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(54) **CONTROL SYSTEM OF A CONTAINER FORMING UNIT COMPRISING A MASTER CONTROL UNIT AND SLAVE CONTROLLERS**

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(57) **ABSTRACT**

A control system (**34**) for a unit (**9**) for forming containers (**2**) from blanks (**3**) provided with a series of forming stations (**10**) each provided with a mould (**11**), the system (**34**) including a master control unit (**36**) and a series of slave controllers (**37**) each associated with at least one forming station (**10**), each controller (**37**) being programmed to: control the or each associated forming station (**10**) according to a forming command (CF) loaded in the controller (**37**); take into account a pressure measurement in the mould (**11**), from this measurement, establish a blowing curve describing the change in the fluid pressure in the mould (**11**), analyze the blowing curve and extract therefrom the coordinates of at least one singular point (S); communicate the singular point (S) to the control unit (**36**).

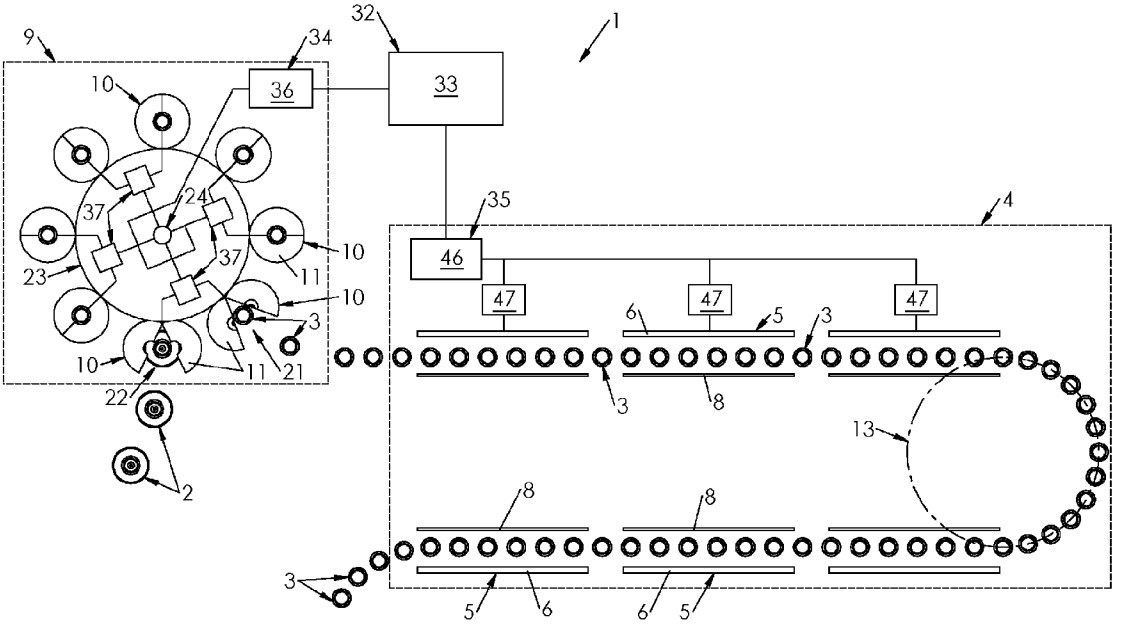
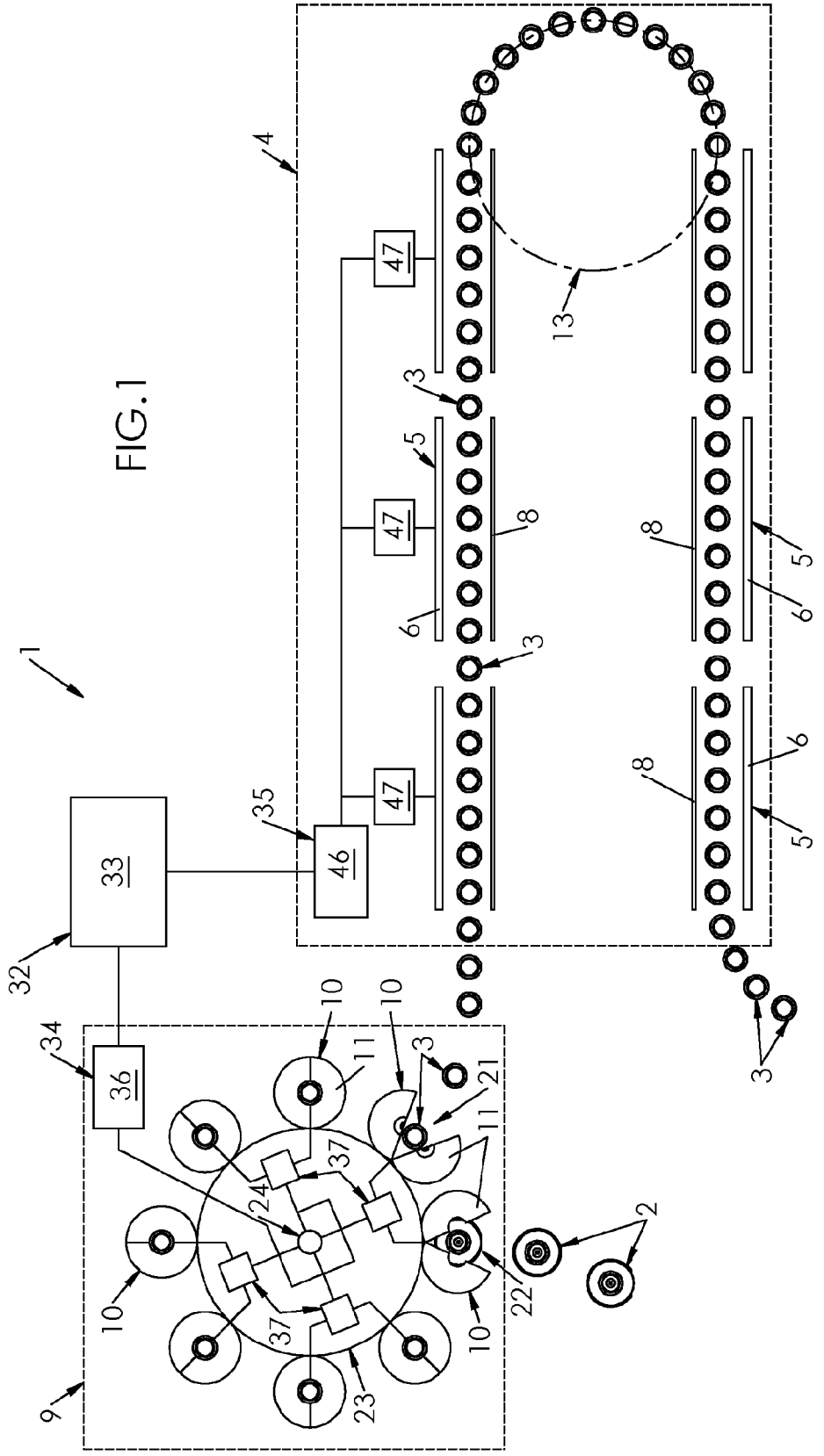


FIG. 1



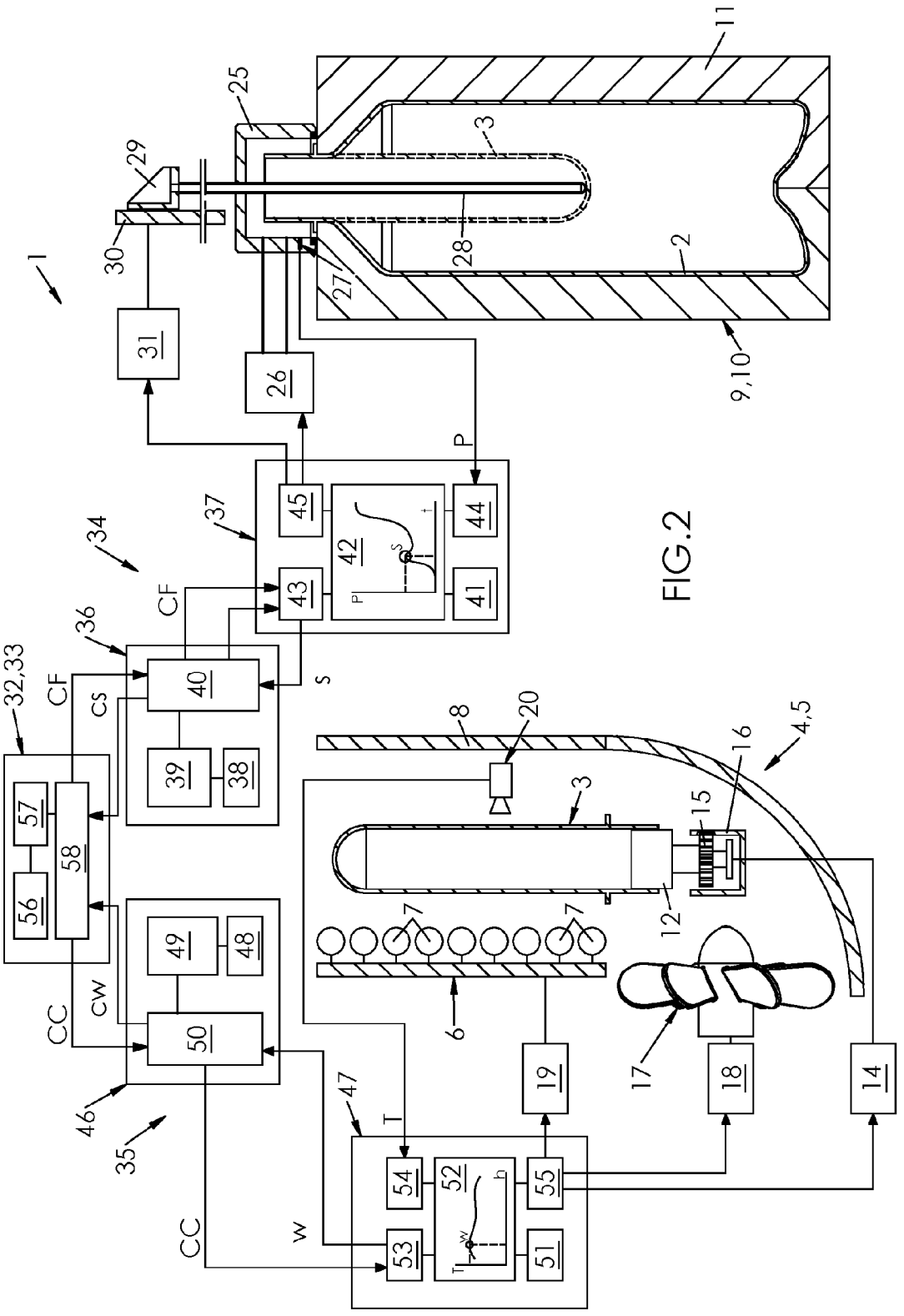

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FIG.2

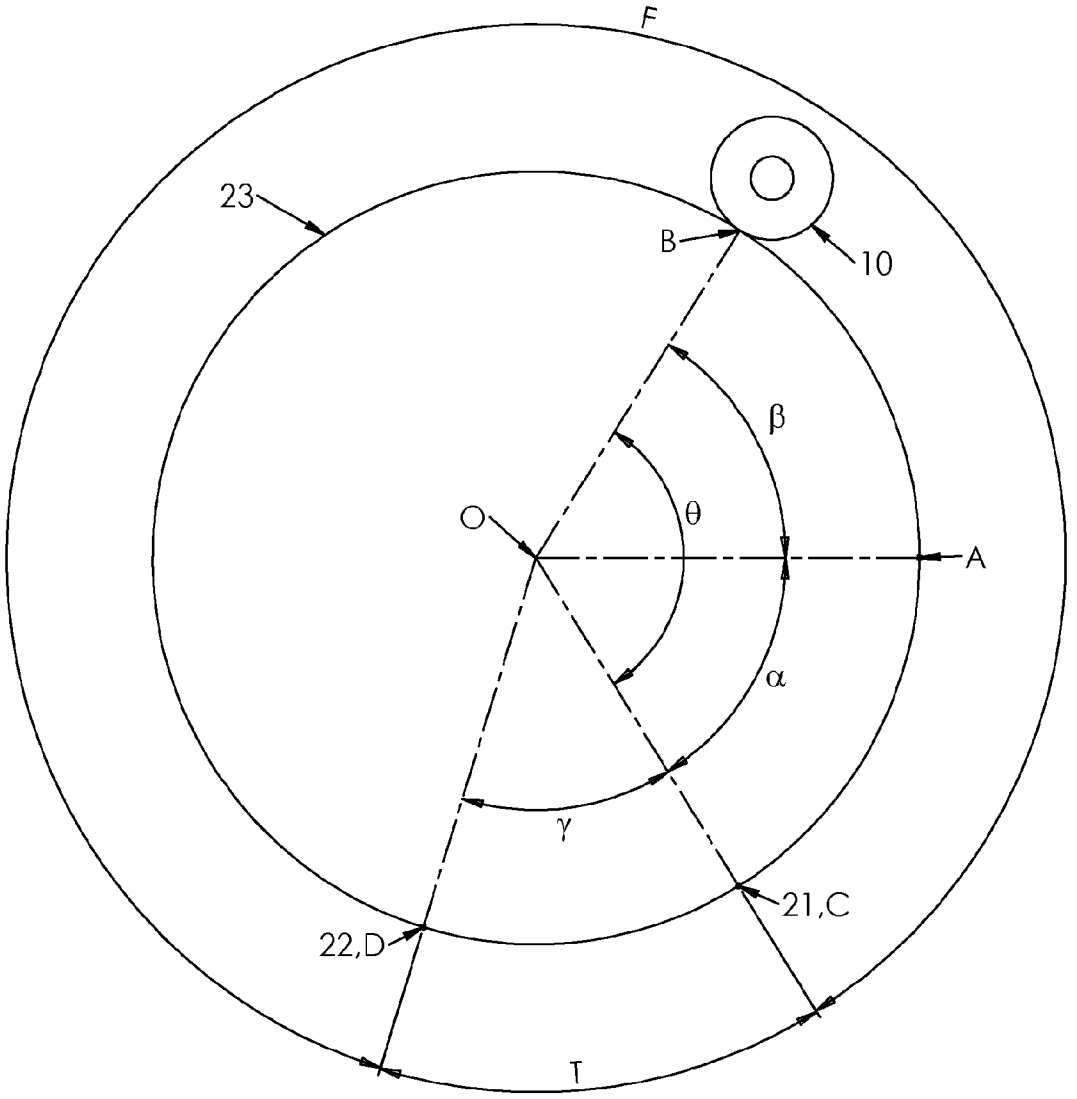

FIG.3

CONTROL SYSTEM OF A CONTAINER FORMING UNIT COMPRISING A MASTER CONTROL UNIT AND SLAVE CONTROLLERS

[0001] The invention relates to the field of forming containers from blanks made of thermoplastic material such as PET (polyethylene terephthalate), with the term "blank" covering both a preform that has been injected and an intermediate container that has undergone one or more temporary forming operations.

[0002] The forming of a container is carried out by blow molding or drawing-blow molding from a blank that has undergone a previous heating operation. The hot blank is introduced into a mold with the imprint of the container; a pressurized fluid (in particular a gas such as air) is then injected into the blank to impart to it the shape of the container by counter-imprint in the mold. The blank can also undergo drawing by means of a sliding rod so as to minimize offsetting and to make the distribution of the material uniform.

[0003] The forming of the containers on the industrial scale imposes extremely short cycle times. For an ordinary modern production rate (on the order of 50,000 containers per hour), the cycle time, measured between the introduction of the blank into the mold and the evacuation of the formed container, is between 1 second and 2 seconds only. The manufacturers aim for even higher production rates, with the goal of 100,000 containers per hour being deemed reasonable in the medium term. At this rate, the individual production of each mold is several thousand containers per hour.

[0004] The risk of shape defects appearing and affecting the containers increases, however, in proportion to the increase in the production rate. The number of the most frequent shape defects include poor imprint-taking and poor distribution of the material, which are often correlated. It is known that these defects can be linked to various machine parameters, in particular the temperature for heating blanks, the pressure and the flow rate of fluid, or else the drawing speed.

[0005] The manual modification of these parameters assumes a fine knowledge, by the operators, of correlations that can exist between the variation applied to a given parameter and the consequence of this variation on the correction of a shape defect. In view of the errors noted and the slowness of the process keeping the operator free from making instantaneous adjustments to the machine, several manufacturers are engaged in an integral automation of the directing of the machine.

[0006] The applicant has already contributed to this trend by systematizing the analysis of blow-molding curves to detect therein singular points able to indicate the conformity (or, in contrast, the non-conformity) of the container to a predefined model, the modification of machine parameters able to be controlled in the case of non-conformity, cf. in particular the documents WO 2008/081107 and WO 2012/035260.

[0007] It is known to direct the machines by means of automated control systems.

[0008] It can be considered to centralize the machine control within a single system, which for the latter simultaneously involves conducting:

[0009] In real time, operations for directing the cycle in progress by controlling the elements of the machine according to preestablished instructions, such as the pressure and the flow rate of blow molding, or else the drawing rate, or else operations for measuring parameters (for example, the pressure prevailing in the container during forming),

[0010] In delayed time, operations useful for the proper execution of the following cycle(s), the analysis of measurements, the calculation, and the implementation of new instructions.

[0011] Such centralization, however, runs into the limits of the performance of the processors because of the high volume of data to be processed and the speed at which these data are to be processed to maintain the pace of production. The risk of causing an overload of the processor, resulting in a malfunction of the machine, is high. An obvious solution would be to limit the production rates or the number of forming stations per machine, but this solution would run counter to the requirements of the market, heading instead toward increased production rates.

[0012] In the European patent application EP 2 098 356, it is proposed to assign a control system to each blow-molding station of a blow-molding wheel, with each system controlling both the injection and the driving of a drawing element. In other words, this document proposes to totally decentralize the machine control, with the exception of initiating operations, which is controlled by a central system, which receives from a sensor a piece of data on the angular position of the blow-molding wheel, relayed to the control system of each blow-molding station.

[0013] Such a decentralization is not, however, completely satisfactory. Actually, with each control system being autonomous, the quality of the containers that are produced may drift without it being easy to detect the causes thereof and the location on the machine. In other words, it is possible to note variations in the quality of the containers produced without it being possible, however, to make it uniform.

[0014] A first object of the invention is to optimize the control of a machine (or unit) for forming containers.

[0015] A second object is to promote an increase in the capacities for production, and in particular an increase in the production rates.

[0016] A third object is to optimize (and in particular to make uniform) the quality of containers produced on a forming machine.

[0017] For this purpose, first of all a system for controlling a unit for forming containers from blanks made of thermoplastic material equipped with a series of forming stations, each equipped with a mold with the imprint of a container, is proposed, with this system comprising a master control unit and a series of slave controllers tied to the master control unit and each associated with at least one forming station, each controller being programmed for:

[0018] Directing the forming station or each associated forming station according to a forming instruction loaded into the controller;

[0019] Taking into account a measurement of pressure in the mold,

[0020] Based on this measurement, plotting a blow-molding curve describing the change in the fluid pressure in the mold,

[0021] Analyzing the blow-molding curve and extracting from it the coordinates of at least one singular point,

[0022] Communicating the singular point to the control unit,

[0023] With the control unit being programmed for:

[0024] Directing the controllers,

[0025] Taking into account the singular point or each singular point communicated by each controller,

[0026] Calculating a characteristic point that is a function of the singular point(s),

[0027] Comparing the characteristic point with a theoretical point memorized in the control unit,

[0028] If a variation is declared between the characteristic point and the theoretical point, issuing a corrected forming instruction,

[0029] Loading the corrected forming instruction into the controller or each controller.

[0030] Various additional characteristics can be provided, by themselves or in combination:

[0031] The characteristic point is an average of singular points communicated by the same controller or by multiple controllers;

[0032] Each controller is associated with two forming stations;

[0033] With each forming station being equipped with an injection device comprising a block of actuators directed by the controller, the forming instruction comprises values of pressure and/or of the flow rate of a fluid delivered by said block, or a control time of the actuator block;

[0034] With each forming station comprising a moving part (for example, a drawing rod) whose movement is directed by the controller, the instruction comprises a movement profile of the part;

[0035] With the forming stations describing a path including a forming sector extending from a point for loading blanks to a point for unloading the formed containers, and a buffer sector, complementary to the forming sector and extending from the unloading point to the loading point, the control unit is programmed to load the modified forming instruction into the controller or each controller when the forming station or each associated forming station is found in the buffer sector;

[0036] With the forming unit comprising a wheel on which are mounted the forming stations, and an angular position sensor of the wheel, each controller is programmed to take into account the instantaneous angular position of the wheel, by deducing the angular position of the forming station or each associated forming station and by plotting the blow-molding curve from pressures measured at times corresponding to each of these angular positions.

[0037] Secondly, a unit for forming containers from blanks made of thermoplastic material, equipped with a series of forming stations each equipped with a mold with the imprint of a container, and a control system as presented above, is proposed.

[0038] Thirdly, an installation for producing containers from blanks made of thermoplastic material, equipped with a forming unit as mentioned above, is proposed.

[0039] Other objects and advantages of the invention will be brought out in the description of a preferred embodiment, given below with reference to the accompanying drawings, in which:

[0040] FIG. **1** is a diagrammatic view showing an installation for producing containers, comprising a forming unit and a heating unit;

[0041] FIG. **2** is a diagrammatic view illustrating in greater detail the architecture of the installation;

[0042] FIG. **3** is a diagrammatic view illustrating the angular positions of a wheel of the forming unit.

[0043] FIGS. **1** and **2** diagrammatically show an installation **1** for producing containers **2** from blanks **3** made of thermoplastic material, for example made of PET (polyethylene terephthalate).

[0044] The installation **1** comprises at least two units **4**, **9** for processing containers **2** or blanks **3**. For the sake of simplicity, it is assumed below that the blanks **3** are preforms.

[0045] Typically, as in the illustrated example, the installation comprises:

[0046] A heating unit **4** or oven, which comprises a series of heating modules **5**, each having a radiant wall **6** equipped with superposed sources **7** of infrared radiation and a reflecting wall **8** placed facing the radiant wall **6** for reflecting the portion of radiation that is not absorbed by the preforms **3**,

[0047] A unit **9** for forming by blow molding or drawing-blow molding, equipped with at least one forming station **10** (and in this case a series of stations), with the forming station or each forming station **10** being equipped with a mold **11** with the imprint of a container.

[0048] In a standard way, the preforms **3** at ambient temperature are introduced into the oven **4** by an input of the latter, for example by means of a wheel or a supply conveyor. Then, the preforms **3** are heated in a stream in the oven **4** at a temperature higher than the glass transition temperature of the material (the final temperature of the blanks is on the order of 120° C. for the PET, whose glass transition temperature is approximately 80° C.).

[0049] In the oven **4**, the preforms **3** are mounted, for example, on pivoting supports **12** or spinners. Each spinner **12** is mounted on a chain circulating on a driving wheel **13** driven in rotation by a motor **14**. The spinner **12** is equipped with a pinion **15** that engages a rack **16** to drive the spinner **12** in rotation during its passage into the oven **4** and thus to expose the surface of each preform **3** to radiation.

[0050] To evacuate at least a portion of the excess heat produced by the radiant wall **6**, the oven **4** can be equipped with an extraction system comprising, for example, a fan **17** driven by a motor **18** and positioned facing the necks of the preforms **3**.

[0051] In addition, the power of the radiation emitted by the radiant wall **6** can be modulated by means of a power variable-speed drive unit **19**, as in the example embodiment illustrated in FIG. **2**.

[0052] The thermal profile of the preforms **3** is preferably controlled, either directly in the oven **4** or at the outlet of the latter, by means of a thermal sensor **20**. According to an illustrated embodiment in FIG. **2**, the thermal sensor **20** is a thermal camera pointing toward the preforms **3**.

[0053] At the outlet of the oven **4**, the thus heated preforms **3** are transferred to the forming unit **9** via a transfer unit (such as a transfer wheel) to be blow-molded or drawn-blow-molded individually in a mold **11**. The preforms **3** are introduced into the forming unit **9** at a loading point **21**.

[0054] At the end of the forming, the containers **2** are evacuated from the molds **11** from an unloading point **22** for the purpose of being directly filled and labeled, or stored temporarily for the purpose of being filled and subsequently labeled. Once filled and labeled, the containers are grouped

and packaged, for example, within a plastic-wrapping unit that envelops each group of containers in a heat-shrinkable film.

[0055] As is also seen in FIGS. **1** and **2**, the forming unit **9** comprises a pivoting wheel **23** on which are mounted the forming stations **10** and a sensor **24** to detect the instantaneous angular position of the wheel **23**, in the form of, for example, a coder (i.e., in practice, an instrument-equipped bearing device).

[0056] Each forming station **10** is equipped with a nozzle **25**, by which a fluid (in particular a gas such as air) is injected into the mold **11**. Each forming station **10** is also equipped with an injection device comprising an actuator block **26** connected to the nozzle **25** for controlling the injection of the fluid. In addition, each forming station **10** is equipped with a device **27** for measuring the prevailing pressure in the container during forming. In the illustrated example, the measuring device **27** comprises a pressure sensor mounted on the nozzle **25**, in which the pressure in the course of forming is identical to the pressure prevailing in the container **2**.

[0057] According to an embodiment corresponding to a process for forming by drawing-blow molding, each forming station **10** also comprises a moving drawing rod **28**, integral with a carriage **29** mounted in translation relative to a support **30**.

[0058] The movement of the rod **28** is controlled in an electromagnetic manner. For this purpose, the support **30** comprises an electromagnetic track connected to a motor **31**, and the carriage **29** itself is magnetic. The sign and the power of the current passing through the track make it possible to move the rod **28** along a predetermined movement profile, comprising a direction and a speed of motion.

[0059] As illustrated in FIG. **1**, the forming stations **10** describe a path (in this case circular) that includes a forming sector F extending from the loading point **21** of the preforms **3** to the unloading point **22** of the containers **2** that are formed, and a buffer sector T, complementary to the forming sector F and extending from the unloading point **22** to the loading point **21**.

[0060] The installation **1** is equipped with a control system **32** that comprises a central unit **33** for control of the installation **1**, and, for each processing unit **4**, **9**, a dedicated control system **34**, **35** that in an automatic way directs the operation of the respective unit **9**, **4**.

[0061] Thus, the forming unit **9** is equipped with a dedicated control system **34** that comprises a master control unit **36** and a series of slave controllers **37** tied to the master control unit **36**.

[0062] The master control unit **36** is computerized and comprises, as illustrated in FIG. **2**:

[0063] A memory **38** into which programs for directing the forming unit **9** are entered,

[0064] A processor **39** connected to the memory **38** for applying the instructions of the programs, and

[0065] A communication interface **40** connected to the processor **39** for communication with external communicating entities, as will be explained below.

[0066] Each slave controller **37** is a programmable logic controller of the type described in W. Bolton, *Programmable Logic Controllers*, Newnes, 5th Edition, 2009.

[0067] More specifically, each controller **37** comprises:

[0068] A memory **41** into which programs for directing at least one forming station **10** are entered,

[0069] A processor **42** connected to the memory **41** for applying the instructions of the program,

[0070] A communication interface **43** connected to the processor **42** for communication with the master control unit **36** via the communication interface **40**,

[0071] An input interface **44** connected, on the one hand, to the processor **42**, and, on the other hand, to the device **27** for measuring the pressure, denoted P, prevailing in the mold **11**,

[0072] An output interface **45** connected, on the one hand, to the processor **42** and, on the other hand, to the actuator block **26** and to the control motor **31** of the drawing rod **28**.

[0073] As a variant, the input and output interfaces **44**, **45** are assembled within an input/output unit interface.

[0074] The controller **37** is programmed to carry out the following operations:

[0075] Directing the forming station **10** with which it is associated (or each forming station **10** with which it is associated; the controller **37** can, for example, be associated with two forming stations **10**) for performing a complete forming cycle along the forming sector F, from the loading of a preform **3** at the loading point **21** to the unloading of the formed container **2** at the unloading point **22**, according to a forming instruction CF that is loaded (i.e., written) into the memory **41**;

[0076] Taking into account a measurement of the pressure P in the mold **11**. The measurement of pressure is carried out by the pressure sensor **27** continuously or in a sequential and uniform manner, at predetermined intervals (for example, 5 ms) and communicated to the processor **42** via the input interface **44**;

[0077] Based on the measurement of pressure, plotting during the forming cycle a blow-molding curve describing the changes in the fluid pressure P in the mold **11** at any time, denoted t (in practice, at times, measured by the internal clock of the processor **42**, corresponding to the angular positions provided by the sensor **27**), this curve (diagrammatically visible in FIG. **2**) being plotted by the processor **42** and memorized during the cycle;

[0078] Analyzing, at the end of the cycle, the blow-molding curve and extracting from it the coordinates of at least one singular point S (in particular, a local pressure peak, typically a point B as defined in the international application WO 2008/081107);

[0079] Communicating, from the end of the cycle, the coordinates of the singular point to the master control unit **36**.

[0080] The forming instruction can comprise pressure values and/or the flow rate of fluid delivered by the actuator block **26** or else a movement profile of the rod **28** or of any other moving part (for example, a mold bottom coupled to the rod **28**), in the form of, for example, a speed curve of the motion of the rod **28** (or of any other moving part) based on its position. The speed of motion of the rod **28** (or of any other moving part) can be converted by the processor **42** of the controller **37** into power to be delivered by the motor **31**. The instruction is applied by the processor **42**, which directs the actuator block **26** and the motor **31** via the output interface.

[0081] The processor **39** of the master control unit **36** is, for its part, programmed for:

[0082] Directing its slave controllers **37**,

[0083] Taking into account the singular point or each singular point S communicated by each controller **37** at

the end of the cycle performed by the forming station or each associated forming station **10**,

[0084] Calculating a characteristic point CS from the singular point(s) S. This characteristic point CS can be the singular point S itself, communicated during a single cycle by a controller **37**, or an average of singular points S communicated during several successive cycles by the same controller **37**, or an average of singular points S communicated during a single cycle by multiple controllers **37**, or else an average of singular points S communicated during several successive cycles by multiple controllers **37**;

[0085] Comparing this characteristic point CS, obtained (or calculated based on) measurements, with a theoretical point entered in advance into the memory **38** of the master control unit **36** and corresponding to a model container,

[0086] If a variation is declared between the characteristic point CS and the theoretical point, issuing a corrected forming instruction CF, comprising a pressure value and/or a fluid flow rate value that is modified to be delivered by the actuator block **26**, or a control time of the actuator block **26**, or else a movement profile of the rod **28** (for example, in the form of a speed curve of the rod **28** or a power curve of the motor **31**, as a function of the position of the rod **28**), or another moving part;

[0087] Loading the corrected forming instruction CF into the controller or each controller **37** directed by the master control unit **36**,

[0088] If necessary, communicating the characteristic point CS to the central control unit **33**.

[0089] When no variation is declared between the characteristic point CS and the theoretical point, no corrected forming instruction is issued by the processor **39**, in such a way that for the new forming cycle or several subsequent forming cycles, the slave controller **37** applies the forming instruction CF of the preceding cycle(s).

[0090] On the assumption, mentioned above, of a correction of the forming instruction CF, the new instruction CF is loaded into the slave controller **37** when the associated forming station **10** is in the buffer sector T, in such a way as to be able to be applied for the following forming cycle, from the loading of a new preform **2** at the loading point **21**.

[0091] The angular position information of the wheel **23** is common to the controllers **37** and shared. It can be centralized at the level of the master control unit **36**, whose processor **39** in this case is programmed to communicate, at predetermined intervals (in particular several milliseconds, for example 1 ms), via its communication interface **40**, the instantaneous angular position of the wheel **23**, as measured by the angular position sensor **24** in a polar coordinate frame of reference centered on the axis of rotation of the wheel, denoted O.

[0092] However, according to a preferred embodiment, the sensor **24** is connected directly, via a local computer network (LAN), to all of the controllers **37**. In this case, so that the information transmitted by the sensor **24** via the network is readable by the controllers, the sensor **24** preferably integrates an analog/digital converter.

[0093] Each slave controller **37** is, for its part, programmed for:

[0094] Taking into account the instantaneous angular position of the wheel **23** as soon as this position is communicated to it by the master control unit **36** or directly by the angular position sensor **24**,

[0095] Deducing from it the angular position of the forming station or each forming station **10** associated with the slave controller **37** and directed by the latter, and

[0096] Plotting the blow-molding curve from pressures measured in the nozzle **25** of each associated mold, at times corresponding to each of these angular positions.

[0097] The calculation of the instantaneous angular position of each forming station **10** can be carried out in the following simple manner by taking as a reference (i.e., the zero angle) the loading point **21** (also denoted C in FIG. **3**).

[0098] Denoted as A is a fixed arbitrary point on the wheel **23**, considered to be a moving reference providing the angular position of the loading point C, denoted α and provided by the position sensor **24**, such that $\alpha=\widehat{COA}$.

[0099] Denoted as B is the point corresponding to the relative angular position, denoted β, of the forming station **10**, measured relative to the point A and such that $\beta=\widehat{AOB}$.

[0100] By denoting as θ the absolute angular position of the forming station **10** in the fixed polar frame of reference that has the OC axis as its origin, this angular position θ is such that $\theta=\widehat{COB}=\widehat{COA}+\widehat{AOB}=\alpha+\beta$.

[0101] Denoted as D is the unloading point **22** (fixed in the polar frame of reference of the OC axis), whose angular position, denoted γ, is such that $\gamma=\widehat{COD}$.

[0102] Thus, for any forming station **10**, the processor **39** of the associated controller, into the memory **38** of which the values of the angles β and γ are entered, is at any time capable of calculating the angle θ by the formula indicated above and of determining if the forming station **10** is located in the forming sector F, in which $0\leq\theta\leq2\pi-\gamma$ (with the angles being expressed in terms of radians) or in the buffer sector T, in which $\theta>2\pi-\gamma$.

[0103] The result from the architecture of the control system **34** is that the tasks necessary to the operation of the forming unit **9** are shared between the master control unit **36** and the slave controllers **37** that are tied to it.

[0104] The tasks attributed to the controllers **37** comprise the effective directing of the forming stations **10** (in particular two stations **10** by each controller **37**), the taking of measurements, and the analysis of these measurements for deducing from them singular points S. These tasks are carried out in real time, as the cycle advances, and require a rapid processing.

[0105] The tasks attributed to the control unit **36** comprise the analysis of data communicated at each end of the cycle by the controllers **37**, making the decision as to whether it is appropriate or not to correct the forming instructions CF, as well as the optional issuing and loading of corrected forming instructions CF. These tasks are carried out for each forming station **10** in delayed time, during which the latter passes through the buffer sector T when the instruction corrections are provided to be applied from one cycle to the next, or during several cycles, when the control unit **36** makes calculations of characteristic points on the basis of averages of measurements made over several cycles.

[0106] This sharing of tasks makes it possible to limit both the volume of data to be processed and the speed at which these data are to be processed by the control unit **36**. In this way, the calculations necessary to the correct conduct of the forming operations do not limit the pace of production.

[0107] As is furthermore shown in a diagram in FIG. **2**, the heating unit **4** is also equipped with a dedicated control sys-

tem **35** that comprises a master control unit **46** and a series of slave controllers **47** tied to the master control unit **46**.

[0108] The master control unit **46** is computerized and comprises:

[0109] A memory **48** into which programs for directing heating modules **5** are entered,

[0110] A processor **49** connected to the memory **48** for applying the instructions of the programs, and

[0111] A communication interface **50** connected to the processor **49** for communication with external communicating entities.

[0112] Each slave controller **47** is a programmable logic controller of the type described in W. Bolton, *Programmable Logic Controllers*, Newnes, 5th Edition, 2009.

[0113] More specifically, each controller **47** comprises:

[0114] A memory **51** into which programs for directing at least one heating module **5** are entered,

[0115] A processor **52** connected to the memory **51** for applying the instructions of the program,

[0116] A communication interface **53** connected to the processor **49** for communication with the master control unit **46** via its own communication interface **50**,

[0117] An input interface **54** connected, on the one hand, to the processor **52**, and, on the other hand, to the heat sensor **20**,

[0118] An output interface **55** connected, on the one hand, to the processor **52**, and, on the other hand, to the power variable-speed drive unit **19** and to the motors **14**, **18** of the driving wheel **13** and the fan **17**.

[0119] The controller **47** is programmed to carry out the following operations:

[0120] Directing the heating module or each heating module **5** with which it is associated, according to a heating instruction CC that is loaded (i.e., written) into the memory **51**;

[0121] Based on the measurement of temperature (denoted T) obtained from the heat sensor **20**, plotting the instantaneous thermal profile of each preform **3**, which can come in the form of a mean temperature measured for the entire preform **3**, of a set of multiple temperature values at different heights in the body of the preform **3**, or a curve providing the temperature T based on the height (denoted h) in the preform **3**;

[0122] Analyzing the thermal profile and extracting from it the coordinates of at least one singular point W (for example, at a given height in the vicinity of the neck);

[0123] Communicating for each preform **3**, or at predetermined intervals, the coordinates of the singular point W to the master control unit **46**.

[0124] The heating instruction CC can comprise a power value delivered by the variable-speed drive unit **19**, a speed of rotation of the motor **18** of the fan **17**, or else a speed of rotation of the driving wheel **13** (and therefore, consequently, a travel speed of the preforms **3**—in other words, the pace of production of the oven **4**).

[0125] The processor **49** of the master control unit **46** is, for its part, programmed for:

[0126] Directing its slave controllers **47**,

[0127] Taking into account the singular point or each singular point W communicated by each controller **47**,

[0128] Calculating a characteristic point CW from the singular point(s) W. This characteristic point CW can be the singular point W communicated at a predetermined time by the controller **47** or an average of singular points W communicated during a predetermined period by the same controller **47**;

[0129] Comparing this characteristic point CW with a theoretical point entered in advance into the memory **48** of the master control unit **46** and corresponding to a preform that has provided a model container,

[0130] If a variation is declared between the characteristic point CW and the theoretical point, issuing a corrected heating instruction CC, comprising a value modified for the power of the variable-speed drive unit **19**, or else for the speed of rotation of the motor **18** of the fan **17** or of the driving wheel **13**;

[0131] Loading the corrected heating instruction CC into the controller or each controller **47** directed by the master control unit **46**;

[0132] If necessary, communicating the characteristic point CW to the central control unit **33**.

[0133] When no variation is declared between the characteristic point CW and the theoretical point, no corrected heating instruction is issued by the processor, so that the controller **47** continues directing the (or each) heating module **5** according to the preceding heating instruction CC.

[0134] As is illustrated in the figures, the central control unit **33** of the installation **1** comprises:

[0135] A memory **56** into which programs for directing the control units **36**, **46** of the dedicated control systems **34**, **35** are entered, with these control units **36**, **46** thus being tied to the central control unit **33** (in other words, the control units **36**, **46** are masters of the controllers **37**, **47** and slaves of the central control unit **33**);

[0136] A processor **57** connected to the memory **56** for applying the instructions of the programs, and

[0137] A communication interface **58** connected to the processor **57** for communication with the control units **36**, **46**.

[0138] The processor **57** of the central control unit **33** is programmed to direct each control unit **36**, **46**, according to a processing instruction CF, CC that is loaded into the processor **39**, **49** of each control unit **36**, **46**.

[0139] It is seen that the control units **36**, **46** can transmit to the central control unit **33** the characteristic points CS, CW.

[0140] This transmission makes it possible for the processor **57** of the central control unit **33** to direct the operation of each processing unit **4** (or **9**) as a function of measurements obtained from another processing unit **9** (or **4**).

[0141] More specifically, the processor **57** of the central control unit **33** is programmed for:

[0142] Taking into account at least one characteristic point CS, CW that is communicated to it by a first control unit **36** (or **46**),

[0143] Comparing this characteristic point with a theoretical point entered into the memory **56** of the central control unit **33**,

[0144] If a variation is declared between the singular point and the theoretical point, issuing a corrected processing instruction CC, CF intended for a second control unit **46** (or **36**), and

[0145] Loading this corrected processing instruction CC, CF into the second control unit **46** (or **36**).

[0146] This sequence of operations can be triggered in particular in the case where a first instruction correction made at the level of a dedicated control system **34** (or **35**) to a given processing unit **9** (or **4**) does not eliminate (or does not dimin-

ish), in the following cycle (or in a predetermined number of cycles), the variation noted between the characteristic point CS, CW and the theoretical point.

[0147] It can also be triggered in the case where it is known (and therefore programmed) that only the correction of a processing instruction CC, CF intended for the second control unit **46** (or **36**) is able to affect (and therefore to correct) the measurements made in the first processing unit **9** (or **4**).

[0148] In the example illustrated, the quality of the final container **2** obtained at the outlet of the forming unit **9** depends in particular on the heating temperature T, which is regulated in the heating unit **4**. The temperature T for heating preforms **3** can actually vary as a function of:

[0149] The intensity of the radiation delivered by the heating modules **5**, which depends on the electrical power that is delivered to them, modulated by the variable-speed drive unit **19**,

[0150] The power of the ventilation, regulated by the speed of rotation of the fan **17**, which is modulated by the motor **18**,

[0151] The travel speed of the preforms **3**, which is modulated by the motor **14** of the wheel **13**.

[0152] Thus, it is understood that an instruction change CC affecting the heating temperature T within the heating unit **4** will have the effect of a modification of the blow-molding curve, and in particular the position of the singular point S detected in the latter by the processor **39** of the controller **37**. This instruction change CC is made according to the following procedure, thanks to the programming described above:

[0153] After having plotted the blow-molding curve, the controller **37** analyzes it and extracts from it the coordinates of the singular point S (typically the point B) and communicates these coordinates to the control unit **36** of the forming unit **9**;

[0154] Having declared that a modification of the forming instruction CF is inadequate for obtaining the desired correction of the position of the singular point S on the blow-molding curve in the following cycle or in a predetermined number of following cycles, the control unit **36** communicates the coordinates of the characteristic point CS to the central control unit **33**;

[0155] The central control unit **33**, programmed for this purpose, determines that the blow-molding curve can be corrected using a modification of the heating temperature T, or of the speed of rotation of the fan **17**, or else the travel speed of the preforms **3** (in other words, the speed of rotation of the wheel **13**) and issues a corrected heating instruction CC to the attention of the control unit **46** of the heating unit **4**;

[0156] The central control unit **33** loads the thus corrected heating instruction CC into the control unit **46** of the heating unit **4**;

[0157] The control unit **46** directs the controllers **47** by applying the thus corrected heating instruction CF.

[0158] This architecture has the following advantages.

[0159] First of all, it makes it possible to unclog the control system **32** of the installation by sharing the tasks among multiple control levels connected to one another according to the master-slave principle:

[0160] The controllers **37**, **47** are programmed to conduct low-level operations over the short term, including the (analog) control of mechanical components;

[0161] The control units **36**, **46** are programmed to conduct intermediate-level operations over a relatively longer term, including the calculation of characteristic points (in particular, averages) as a function of measurements received from the controllers **37**, **47**, the comparison with reference values, the issuing of instructions (optionally corrected) and the directing, as a function of these instructions, of the controllers **37**, **47**;

[0162] The central control unit **33** is programmed to conduct higher-level operations over the long term, including taking into account data communicated by the control units **36**, **46**, the issuing of instructions, and directing, as a function of these instructions, the control units **36**, **46**.

[0163] Secondly, this architecture makes possible a dialogue between the different processing units **4**, **9** of the installation **1** without it being necessary to centralize all of the operations within the central control unit **33**, to which only tasks of decision-making, correcting instructions CF, CC and loading corrected instructions CF, CC into the control units **36**, **46** that are tied to it can be assigned.

[0164] Thirdly, thanks to the dialogue between the different control levels, the programming of the entire control system **32** can be centralized on the higher level, i.e., in the central control unit **33**, which can relay to the control units **36**, **46** the program that is dedicated to them as well as the program dedicated to the controllers **37**, **47**, with the control units **36**, **46** relaying in their turn to the controllers **37**, **47** the program dedicated to the latter. It is therefore unnecessary to load the programs individually into each controller **37**, **47** or even into each control unit **36**, **46**. The result is a simplification of the programming of the installation and an increased productivity.

[0165] Fourthly, this architecture makes it possible to carry out a transverse retroaction, i.e., to control a modification of the instruction applied by a processing unit—typically the heating unit **4**—as a function of measurements made within another processing unit—typically the forming unit **9**. The quality of the containers produced is improved.

1. System (**34**) for controlling a unit (**9**) for forming containers (**2**) from blanks (**3**) made of thermoplastic material equipped with a series of forming stations (**10**), each equipped with a mold (**11**) with the imprint of a container (**2**), with this system (**34**) being characterized in that it comprises a master control unit (**36**) and a series of slave controllers (**37**) tied to the master control unit (**36**) and each associated with at least one forming station (**10**), each controller (**37**) being programmed for:

Directing the forming station or each associated forming station (**10**) according to a forming instruction (CF) that is loaded into the controller (**37**);

Taking into account a measurement of pressure in the mold (**11**),

Based on this measurement, plotting a blow-molding curve describing the change in the fluid pressure in the mold (**11**),

Analyzing the blow-molding curve and extracting from it the coordinates of at least one singular point (S),

Communicating the singular point (S) to the control unit (**36**),

and in that the master control unit (**36**) is programmed for:

Directing the controllers (**37**),

Taking into account the singular point or each singular point (S) communicated by each controller (**37**),

Calculating a characteristic point (CS) that is a function of the singular point(s) (S),

Comparing the characteristic point (CS) with a theoretical point memorized in the control unit (**36**),

If a variation is declared between the characteristic point and the theoretical point, issuing a corrected forming instruction (CF),

Loading the corrected forming instruction (CF) into the controller or each controller (**37**).

2. System (**34**) according to claim **1**, wherein the characteristic point (CS) is an average of singular points (S) communicated by the same controller (**37**) or by multiple controllers (**37**).

3. System (**34**) according to claim **1**, wherein each controller (**37**) is associated with two forming stations (**10**).

4. System (**34**) according to claim **1**, wherein with each forming station (**10**) being equipped with an injection device comprising a block (**26**) of actuators directed by the controller (**37**), the forming instruction (CF) comprises values of pressure and/or of the flow rate of a fluid delivered by said block, or a control time of the actuator block.

5. System (**34**) according to claim **1**, wherein with each forming station (**10**) comprising a moving part (**28**) whose movement is directed by the controller (**37**), the forming instruction (CF) comprises a movement profile of the part (**28**).

6. System (**34**) according to claim **1**, wherein with the forming stations (**10**) describing a path including a forming sector (F) extending from a loading point (**21**) of the blanks (**3**) to an unloading point (**22**) of the formed containers (**2**), and a buffer sector (T), complementary to the forming sector (F) and extending from the unloading point (**22**) to the loading point (**21**), the control unit (**36**) is programmed for loading the modified forming instruction (CF) into the controller or each controller (**37**) when the forming station or each associated forming station (**10**) is in the buffer sector (T).

7. System (**34**) according to claim **1**, wherein with the forming unit (**9**) comprising a wheel (**23**) on which are mounted the forming stations (**10**), and an angular position sensor (**24**) of the wheel (**23**), each controller (**37**) is programmed for taking into account the instantaneous angular position of the wheel (**23**), deducing from it the angular position of the forming station or each associated forming station (**10**), and plotting the blow-molding curve from pressures measured at times corresponding to each of these angular positions.

8. Unit (**9**) for forming containers from blanks made of thermoplastic material, equipped with a series of forming stations (**10**), each equipped with a mold (**11**) with the imprint of a container, wherein it is also equipped with a control system (**34**) according to claim **1**.

9. Installation (**1**) for producing containers (**2**) from blanks (**3**) made of thermoplastic material, wherein it is equipped with a forming unit (**9**) according to claim **8**.

10. System (**34**) according to claim **2**, wherein each controller (**37**) is associated with two forming stations (**10**).

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